

Investigating the Potential Range Expansion of the Vector Mosquito *Aedes aegypti* in Mexico with NASA Earth Science Remote Sensing Results

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Goal

To employ an integrated (social, environmental, and epidemiological) modeling approach toward understanding the survival and abundance of the mosquito vector *Aedes aegypti*, the primary transmitter of dengue viruses, and the potential for its range to expand toward heavily populated high elevation areas such as Puebla and Mexico City under various climate change and socio-economic scenarios.



Environmental Health Implications

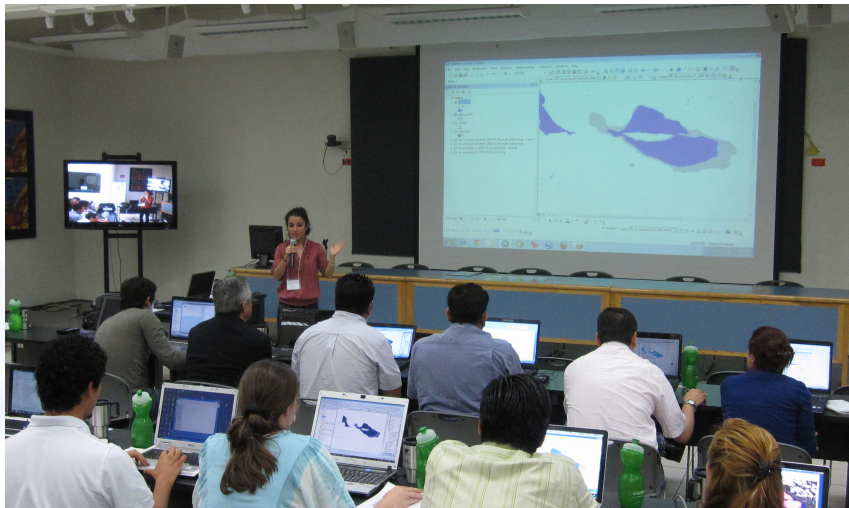
- Dengue (Breakbone) fever is caused by one of four viruses carried by mosquitoes in tropical and subtropical areas.
- Cases have increased dramatically in the past few decades; there are currently ~100 million infections annually around the globe.
- This project integrates environmental observations, including weather, land use, vegetation type, amount and greenness, soil moisture, and mosquito populations with investigations of the human dynamics of the system via household surveys.

Objective 1

Employ NASA remotely-sensed data to augment environmental monitoring and modeling. These data -- surface temperature, precipitation, land cover, vegetation indices, soil moisture and elevation -- are critical for understanding mosquito habitat needed for survival and abundance.

Objective 2

Implement training sessions by USRA/NASA personnel to transfer remotely-sensed data products and habitat analyses to end users and to facilitate continued monitoring



➤ **A training session was conducted at the University of Veracruz, Xalapa, 20-22 March 2012: ‘Introduction to SERVIR for decision-making through the use of GIS and remote sensing’.**

“Introduction to SERVIR for decision-making through the use of GIS and remote sensing”

“Introducción a SERVIR para la toma de decisiones a través del uso de SIG y teledetección”

Agenda

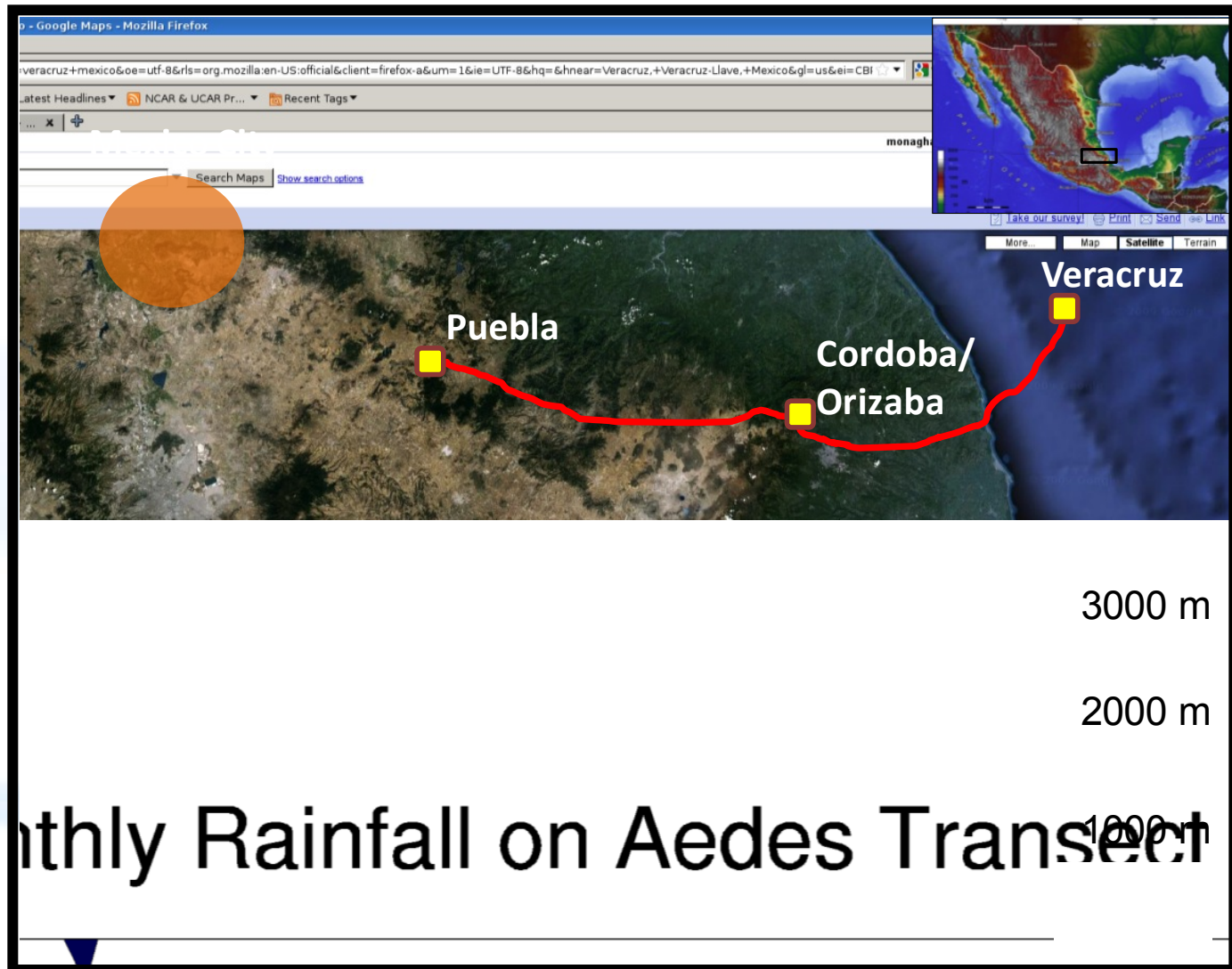
Xalapa, Mexico, March 20 – 22, 2012

Time / Hora	Activity / Actividad
Tuesday, March 20	
8:00 – 8:20 AM	Opening words / Palabras de Apertura
8:20 – 9:20 AM	Overview of Dengue Fever Project/ NCAR
9:20 – 10:00 AM	Overview of SERVIR / Descripción general de SERVIR
10:00 – 10:30 AM	Introduction to Remote Sensing / Introducción a teledetección
10:30 – 10:45 AM	Coffee Break
10:45 AM – 12:00 PM	Where/how to find and download satellite images / Donde/como encontrar y descargar imágenes satelitales
12:00 – 1:00 PM	Lunch
1:00 – 2:00 PM	Basic principles of Remote Sensing / Principios basicos de Teledetección
2:00 – 3:30 PM	Properties of Multispectral satellite images / Propiedades de imágenes Multiespectrales

Objective 3

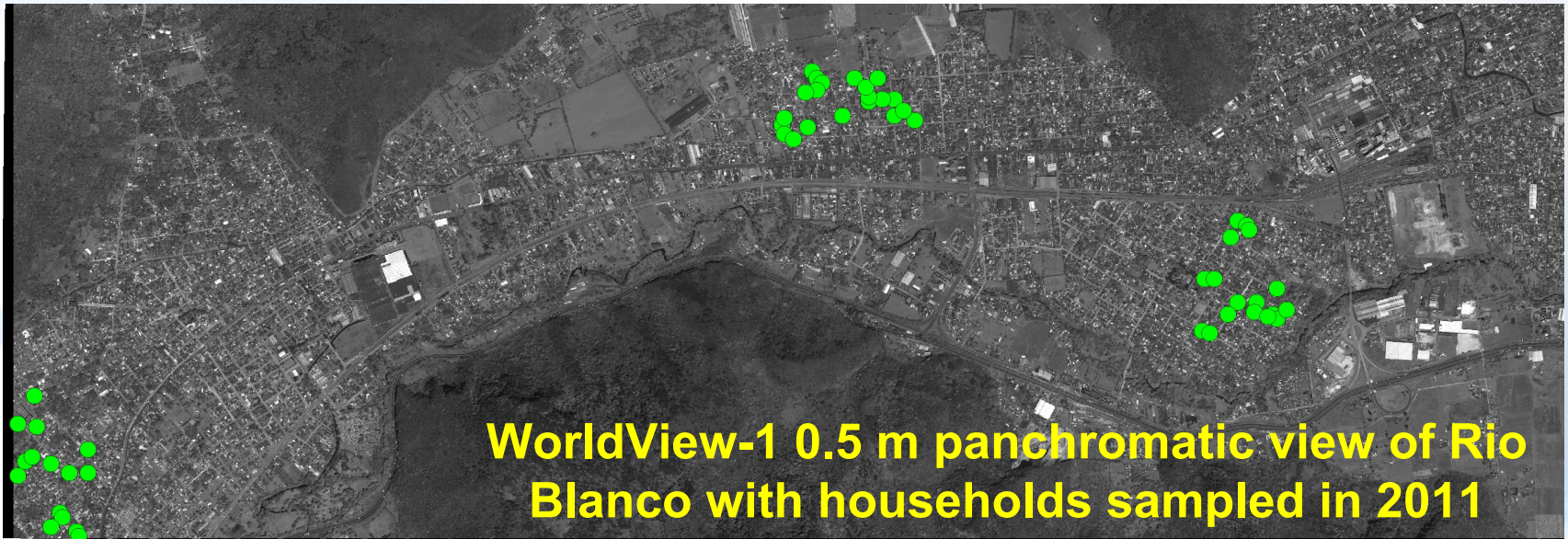
**Integrate data products into the
NASA SERVIR framework to
disseminate key project results**

Sampling Transact



Project Outcomes

- First year of field work was conducted in summer 2011 to sample pupae, larvae and adult *Aedes Aegypti* in 12 communities.
- Second year of field work conducted in summer 2012 to sample pupae and adult *Aedes Aegypti* in 4 communities – Rio Blanco, Maltrata, Acultzingo, Puebla – at the habitat margin.



WorldView-1 0.5 m panchromatic view of Rio Blanco with households sampled in 2011

Project Outcomes

- Climate and remote sensing data have been collected for use in modeling and analysis.
- A preliminary climate-based model has been developed to predict presence and abundance of *Aedes Aegypti* in households.

Aedes aegypti habitat model

- A regression model was developed using 2011 field data to estimate the spatial pattern of *Aedes aegypti* 'potential presence'.

- Dependent variable:

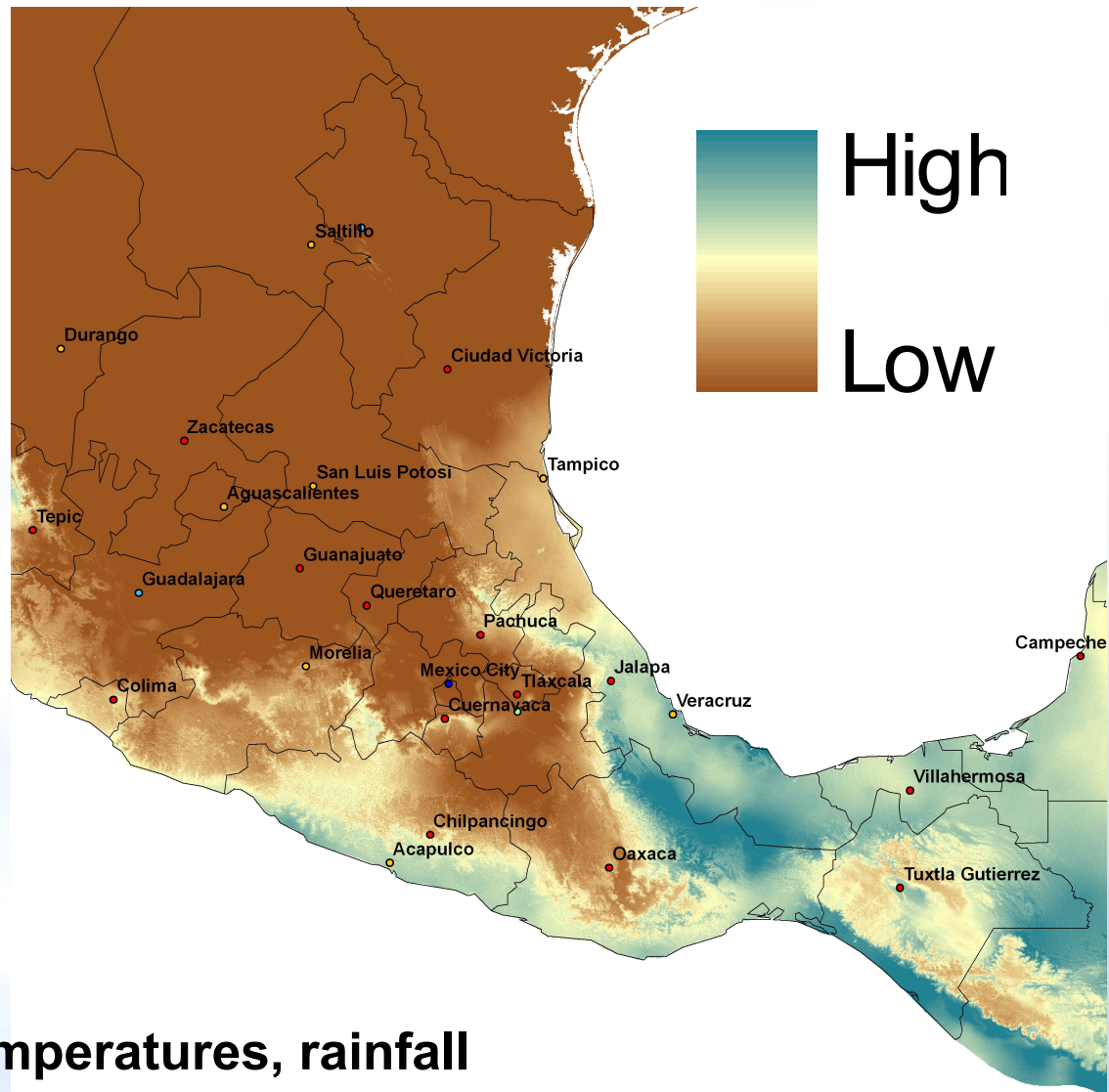
- ✓ Proportion of households in community where *Aedes aegypti* were detected

- Independent variables:

- ✓ Elevation

- ✓ Past 30 days min/max temperatures, rainfall

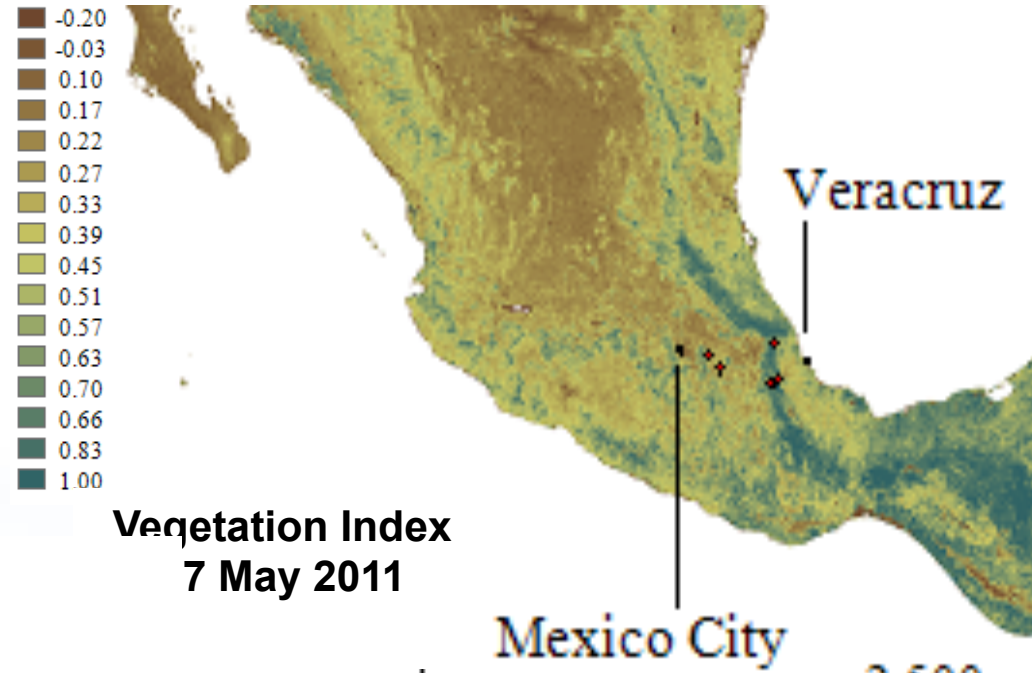
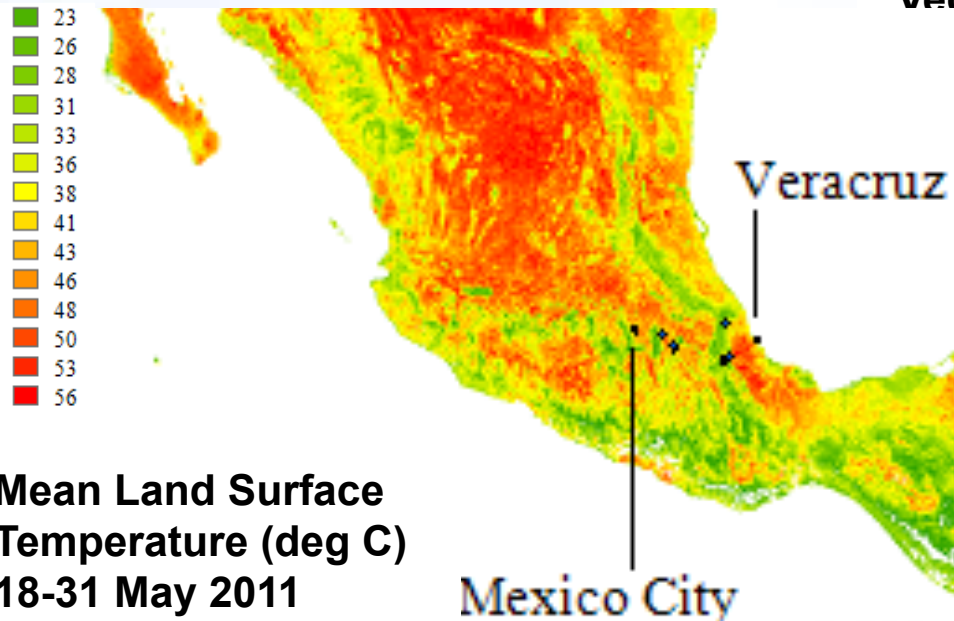
- ✓ Winter mean minimum temperature



Data Products for SERVIR

➤ Remotely-sensed data for Southern and Central Mexico:

- NDVI (Monthly)
- LST (Daily; Day and Night)
- Digital Elevation (30m horizontal resolution)
- Land Cover Land Use 2009



Data Products for SERVIR

- **Statistical analyses of correlations between mosquito presence and abundance and remotely-sensed data:**
 - **NDVI vs *Aedes aegypti* presence/abundance**
 - **LST day and LST night vs *Aedes aegypti* presence/abundance**
 - **Digital Elevation (30m, 250m) vs *Aedes aegypti* presence/abundance**
- **World climate data for Central Mexico**
 - **Monthly means over 30-year period of: Daily maximum, minimum and mean temperature, daily total precipitation**
- **Socio-economic data**
 - **Household level from surveys (i.e. housing type, size, containers, mosquito control, water system characteristics, etc.)**
 - **Community level from Census (% poverty, education levels, etc.)**
- **Map products for Southern and Central Mexico:**
 - ***Aedes aegypti* presence (observed and modeled)**
 - **Climate change effects on habitat suitability**

Impacts and Lessons Learned

- **Impacts**

Mosquitoes were discovered at higher elevations than previously reported.

Publications:

- **Several conference presentations**
- **Several papers in development stage**

- **Lessons Learned**

- **There is very high variability in *Aedes aegypti* presence and abundance between households in a community; much of this is not explainable on first inspection.**

Issues

- Remote sensing of *Aedes aegypti* habitat is difficult due to very small spatial scales.



Mosquito condominium

- Correlations between remotely-sensed environmental parameters (NDVI, LST, land cover) and *Aedes aegypti* presence/abundance are poor at the sub-community scale.

Costing Status

- **Work on the 2-year project began in May 2011. All funds have been received. We are on track with spending, having spent 65% of the funds through August 2012.**

Upcoming Plans

- Develop '2nd generation' *Aedes aegypti* presence model based solely on remote sensing data: temperature, vegetation, rainfall, elevation, land cover
- Develop maps for climate change scenarios, i.e. a warmer climate
- Submit at least 2 manuscripts for publication by summer 2013

